CORRELATION OF COMPUTED TOMOGRAPHY IMAGING FINDINGS WITH GLASGOW COMA SCALE AMONG ADULT PATIENTS WITH HEAD INJURY IN SOKOTO, NORTH WESTERN NIGERIA

BY

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NOVEMBER 2017

DECLARATION
I hereby declare that this research project was carried out by me during the course of my residency training in the Radiology Department of Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto, North Western Nigeria.

SIGN…….. …..DATE……..

Dr MUSA Abubakar
This is to certify that this research was carried out by Dr MUSA, Abubakar during the course of his residency training in the Radiology Department of Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto, North Western Nigeria.

SIGN…………….DATE……..

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HEAD OF DEPARTMENT.

ATTESTATION
This is to attest that this research was carried out by Dr MUSA, Abubakar during the course of his residency training in the Radiology Department of Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto, North Western Nigeria.

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DEDICATION
This work is dedicated to my late father Mallam Musa and my supportive mother Mrs. Amina through whom God brought me to this world.

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**LIST OF ABBREVIATIONS**
SUMMARY

BACKGROUND: Head injury is trauma to the head with or without injury to the brain. The incidence is on the increase due to the rapid growth in infrastructure, politics and interpersonal violence. The incidence of head injury is higher among young adults who constitute the most active and productive in any society.
AIM AND OBJECTIVES: The aim of this study is to determine the computed tomographic findings as well as the correlation between CT findings with the severity of the head injury using GCS.

MATERIAL AND METHODS: This was a prospective cross sectional study on 231 adult patients who had CT scan of the head following trauma from August 2014 to August 2015. A GE 4 slices Bright speed spiral CT machine was used for the study.

RESULTS: Road traffic accident accounted for 90% of the causes of head injury in this study and the most affected age group was 21-30 years with an overall mean age and SD of 38.12 ± 13.58 years. Midline shift of ≥ 5mm showed statistically significant relationship with severity of head injury, P < 0.001. There was positive correlation between CT findings with severity of head injury using GCS.

CONCLUSION: Road traffic accident plays a major role as cause of head injury in our society. GCS and CT scan are useful in the evaluation of head injured patients.

KEY WORDS: Head injury, computed tomography, Glasgow coma score.

INTRODUCTION

Head injury is defined as physical damage to the scalp, skull and/or brain produced by an external force. However such force or impact responsible for the injury needs not to be applied directly to the head. Depending upon whether or not the dura mater was torn, head injury may be termed as open or closed
type\textsuperscript{1,2}. The extent and degree of head injury and its contents is not necessarily proportional to the quantum of force applied to the head\textsuperscript{1}.

Head injury is one of the leading causes of mortality and morbidity in both developed and developing countries\textsuperscript{2}. The incidence of head injury is higher among young adults with a male preponderance in a ratio of male to female of 3.5:1, and this age group is the most active and productive in any society\textsuperscript{3,4,5}. The cause and pattern of head injuries have been reported in literature to vary from one part of the world to another partly because of variation in infrastructure, civil violence, war and crime\textsuperscript{6}. A clear understanding of the cause, injury pattern and classification of these patients is essential for establishment of preventive strategies as well as treatment protocol.

Blunt injury occurs when external mechanical force leads to rapid acceleration or deceleration with brain impact\textsuperscript{7}. It is typically found in the setting of motor vehicle related injury, falls, crush injuries or physical altercation\textsuperscript{4}. Penetrating injury occurs when object pierces the skull and breach the dura mater, seen commonly in gunshot and stab wounds\textsuperscript{3,4}. Blast injury is commonly seen in bombing and warfare due to a combination of contact and inertial forces, overpressure and acoustic wave\textsuperscript{4}. 
Primary injuries are those injuries that occur at the time of impact. They range from minor concussion injury to severe brain damage. Secondary injuries may follow any time after the impact and are potentially preventable.7

The major primary lesions are extra-cerebral hemorrhage, which include acute subdural hematoma, acute epidural hematoma and intra-axial lesion and intra-cerebral hemorrhage.8

Secondary lesions include herniation, diffuse cerebral swelling and secondary infarction and hemorrhage. The duration and severity of secondary damage influence the outcome.8 Head injury can be classified using Glasgow Coma Scale (GCS) into mild, moderate and severe head injury.

The GCS was initially described by Teasdale and Jennet in 1974, and is currently the most widely used parameter for assessment of consciousness level.9 The GCS is one of the most common tools used by trauma care providers as it enables the grading of severity of head injury using simple observation rather than invasive or specialist technique.8 By determining the patient’s level of consciousness using GCS score and computed tomographic (CT) scan findings in head injury, the patient’s medical condition can be evaluated and appropriate intervention made.9 Some clinical condition has great impact on the GCS ratings such as pharmacological sedation and intubation.9 The severity of head injury is initially
assessed by the GCS score. However, the actual severity of head injury is predicted more accurately by CT findings\textsuperscript{8}. CT findings in head injury vary according to the trauma severity that is in accordance with the GCS score\textsuperscript{9}.

It is necessary for every patient who suffers a head injury to undergo a CT scan. In the acute phase, the indications are deterioration of the patient’s conscious level with or without focal neurological signs. Sedation and or general anesthesia should be employed without hesitation when indicated, since the recently traumatized patient may be restless\textsuperscript{10}. Computed tomography scan is the gold standard for the detection of intracranial abnormalities in head injury\textsuperscript{8}.

In addition over the last decade, there have been significant advances in the field of neuro imaging of these patients with the development of helical and new multi slice CT scanners\textsuperscript{9}.

This study was undertaken to determine the clinical severity of head injury using GCS, computed tomographic findings, correlation of CT scan findings with GCS and prevalence of common causes among patients with head injury in Sokoto.

**AIMS AND OBJECTIVES**

**BROAD OBJECTIVE:** To determine the correlation of CT scan findings with Glasgow coma score among patients with head injury in Sokoto.

**SPECIFIC OBJECTIVES**
1. To determine the clinical severity of head injury using Glasgow coma scale.
2. To determine the computed tomographic findings in patients with head injury.
3. To determine the correlation between computed tomographic imaging findings with clinical severity of head injury using Glasgow coma score.
4. To determine prevalence of common causes of head injury among the patients studied.

HYPOTHESIS

There is no significant correlation between Glasgow coma score and computed tomography imaging findings in assessing severity of head injury.

SUBHYPOTHESIS

The computed tomographic findings in the head injured patients are not dependent on the cause of head injury.

JUSTIFICATION

The severity of head injury is initially assessed and classified using GCS and complimented by CT scan findings that show anatomical lesions in extent and depth. Various studies mainly in Caucasians have shown a correlation between
GCS score and CT scan findings. A correlation of the two (GCS and CT scan findings) will help clinicians to identify patients with clinically significant lesions on CT which may result in better management of such cases thereby reducing morbidity and mortality. The paucity of literature on this subject matter in our locality is the reasons for this study.

This study will also increase awareness about the usefulness of CT in the management of head injury.

**RELEVANCE OF THE STUDY TO MEDICAL PRACTICE**

The validation of the correlation between CT scan findings and GCS used for classification of clinical severity of head injury is necessary as the latter is one of the indications for CT scan request. It will also add to the knowledge and experience of the clinician in relating clinically significant lesions with CT scan findings. CT findings also help the clinician in assessing the extent of a brain lesion.

**ANATOMY**

**Gross Anatomy**

The bone of the head is called the skull. The skull can be divided into two main parts, the skull vault (calvaria) and facial bones.
The skull vault is made up of several bones which are joined at sutures and covered by periosteum which is continuous with the fibrous tissue.

The cranial cavity contains the brain. The cerebral hemispheres fill the cranial cavity above the tentorium cerebella. Right and left hemispheres are connected by the corpus callosum and are otherwise partly separated by the median longitudinal fissures. The hemispheres consist of basal ganglia, thalamus, hypothalamus, pituitary gland, and limbic lobe. The lateral ventricles form a cavity within each hemisphere.

The cerebellum lies in the posterior fossa. It is separated from the occipital lobe by the tentorium and from the Pons and midbrain by the forth ventricle. It connects to the brain stem by the three pairs of the cerebellar peduncles.

**CT Anatomy of the brain**

Identification of the brain lobes on CT slices depends on identification of their boundaries. The sylvian cistern and fissures separate the frontal and temporal lobes. The central sulcus that forms a boundary between the frontal and parietal lobes is less well seen. The parieto-occipital sulcus on the medial surface of the hemisphere can be seen on CT at the level of the lateral ventricles. The parieto-occipital junction on the lateral surface has no anatomical landmark.
On axial CT section through the Pons, the cerebellum is seen to be separated from the Pons by the fourth ventricle and connected on each side of this by the middle cerebella peduncles. At this level the cerebellum is bounded interiorly by the petrous temporal bones.

On the higher slices the cerebellum is separated from the temporal and occipital lobes by tentorial margins. The superior vermis can be seen between the occipital lobes on section through the thalamus\textsuperscript{11}.
Figure 1. A sketch of a cross section of the brain at the level of interventricular foramina of Monro.
LITERATURE REVIEW

Role of Computed Tomography

Computed Tomography (CT) scan is the modality of choice for imaging patients with head injury\textsuperscript{12} and the gold standard for the detection of intracranial abnormalities and a safe method for survey in head injury\textsuperscript{8}. From a practical standpoint, a CT scan is positive if it reveals an acute traumatic intracranial lesion that requires either intervention or observation, e.g. subarachnoid hemorrhage, parenchyma hematoma, cerebral contusion or skull fracture\textsuperscript{13}. Fewer than 10\% of patients with minor head injury have positive findings on CT scanning. However, less than 1\% requires neurosurgical intervention\textsuperscript{13}. Some workers feel that only those with loss of consciousness, mild reduction in their Glasgow Coma Scale (GCS) score or skull fracture should have CT scan\textsuperscript{14}.

Conversely others believe that no common clinical parameters are predictive of intracranial injury and advocate liberal use of CT scan on the basis of mechanism of head injury\textsuperscript{15}. It has been further demonstrated that routine early CT scan of the head in head injury is not only the most reliable but also the most cost saving management procedure when compared with hospital admission on the cost of several missed injuries\textsuperscript{14,16}. 


Recommendation on the use of cranial computed tomography (CT) scanning vary from mandatory scanning in all patients to more selective use based on a constellation of findings in the history and physical examinations\textsuperscript{15}. In developed countries a CT scan is even recommended for patients with mild head injury because one in five of such patients will have an acute lesion detected by CT scanning\textsuperscript{5}. However this is not universally accepted while some believe that a thorough clinical examination of the patient may obviate the need for what they feel is an inefficient use of CT in head injury\textsuperscript{5}. Others support the view that clinical examination in head injured patients may not be reliably predictive of eventual CT scan finding.\textsuperscript{5} Srinivasan in his study reported CT scan to be one of the important predictors of head injury\textsuperscript{16}. Moreover in sub-acute and chronic stages Magnetic Resonance Imaging is superior to CT in detecting hemorrhage.

**Clinical assessment using GCS**

It has been shown that GCS cannot completely exclude the presence of intracranial injury following trauma\textsuperscript{17}, though GCS describes and assesses coma, monitors changes in coma and is an indicator of severity of head injury\textsuperscript{18}. However it has been suggested that in order to detect all clinically significant lesions every patient who suffers a minor head injury will have to undergo CT scan\textsuperscript{17}.
A single isolated GCS is of limited value and is insufficient to determine the degree of parenchyma injury after trauma, so patients who sustained head injury should have serial GCS performed over the first several hours post-injury\textsuperscript{14,19}. The objective of GCS score criteria varies across studies\textsuperscript{14}.

Studies have revealed that GCS score apparently correlate with severity of damage inside the skull\textsuperscript{20, 21}. It can be measured with sufficient reliability by the health care provider\textsuperscript{21}. A study by Naseri et al in Iran showed that there is statistical significant relationship between the presence of intracranial abnormalities and lower GCS score. They also noted that as the severity of head injury increases, associated head CT findings proportionately increase\textsuperscript{22}.

Glasgow coma scale CS is based on a 15 points scale which test eye opening, verbal and motor response.
Table 1: Showing the Glasgow coma scale score

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<td>Eye opening</td>
<td>None</td>
</tr>
<tr>
<td>Verbal response</td>
<td>None</td>
</tr>
<tr>
<td>Motor Response</td>
<td>None</td>
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The final score are determined by adding the values assessed using the three parameters. These values help the physician to classify the severity of head injury into mild (GCS13-15), moderate (GCS 8-12) and severe (GCS less than 8)\textsuperscript{23}. The majority of head injury classified according to GCS score is mild\textsuperscript{22}. These classes constitute a more heterogeneous group regarding the diagnostic and therapeutic needs\textsuperscript{20}. The increasing evidence of inadequacy of GCS scoring system in therapeutic and diagnostic decision making in this group makes the definition of mild head injury to be questioned in neurosurgery literature\textsuperscript{20, 23}. Attempt has been made to further subdivide this class into high and low risk subgroups by the use of additional clinical data such as loss of consciousness, presence of amnesia, old age, depressed skull fractures and basal skull fracture\textsuperscript{20, 21}. Effort has also been concentrated on separating patients with GCS of 13-14 from 15\textsuperscript{20}. Therefore head injury is more appropriately defined as mild if loss of consciousness, confusion and disorientation is shorter than 30 minute with CT or MRI scans often normal. This made Bruce et al in their work to say that mild head injury can only be clearly defined after radiologic diagnosis is made\textsuperscript{14}.

**Relationship between clinical assessment and CT findings**

On the other hand, several authors reported that greater percentage of patients with mild head injury have normal CT scan and those with positive CT scan
findings are characterized most frequently by subgaleal hematoma, fractures and cerebral contusion\textsuperscript{20, 22}. Other studies, however found craniofacial fractures to be the most frequent lesions\textsuperscript{9, 22}.

In a study by Ohagbulam et al in Enugu, Nigeria they found all the moderately head injured patients to have subgaleal hematoma. Skull fractures, cerebral contusion and cerebral edema presented with approximately same incidence of 50\%. Another study however, revealed extra-cranial hematoma of less than 1.5cm thick, fractures of the skull and cerebral contusion to be the common findings\textsuperscript{5}.

Studies have shown the following to be common CT findings in severe head injury; subarachnoid hemorrhage of more than 3mm, intra-ventricular hemorrhage and severe depressed fractures. The presence of epidural hematoma alone of less than 5mm has however been noted not to be associated with severe head injury\textsuperscript{22, 23}. On the other hand a study by Sedat D et al revealed the most consistent abnormalities in severe head injury to be severe mid line shift, compression of the cisterns and traumatic subarachnoid haemorrhage\textsuperscript{20}. While Toyoma Y et al found intracranial hematoma with associated mass effect and subarachnoid hemorrhage with associated intra-cerebral hematoma or depressed skull fracture\textsuperscript{8}. 
Morgado et al reported that 80.1% of severe head injury has abnormal CT findings. The patients with apparently normal CT scan findings and clinical evidence of severe head injury were thought to have diffused axonal injury which is not frequently diagnosed with CT scan⁹.

**CT Tomography patterns**

On plain CT, hemorrhagic contusions appear as heterogeneous lesion with central hyperdense area surrounded by an irregularly margined hypodense component. The hyperdense portion represents acute hemorrhage while the hypodense component reflects edema and necrosis. This mixture creates a mottled or salt and pepper pattern⁸. Non hemorrhagic contusions are hypo dense and often difficult to visualize.

Majority of patients with severe head injury are thought to have some degree of diffuse axonal injury, some of which are microscopic and not detected by CT⁴.

Subdural hematoma represents collection of blood located between the dura and arachnoids membrane. The classical CT appearance is a crescent shaped homogeneously hyperdense (acute) or hypodense (chronic) collection that spread diffusely over the affected brain parenchyma⁸. Subdural hemorrhages were found in a study by Muhammed et al in India to be predominantly in the frontal and parietal region²⁴.
The subarachnoid hemorrhage usually arises from bleeding into the subarachnoid space; CT shows increased attenuation in the cortical fissures and sulci or basal cisterns. It is seen more often in cortical sulci near the surface than in the basal cisterns as in aneurysmal rupture.\(^8\)

Intra-cerebral hematomas result from shearing or rapid deceleration injuries. Blood vessels are torn, and blood is extravasated into brain parenchyma. The majority occur in temporal lobes or the basal ganglia\(^1,8\).

Intra-cerebral hematomas are often demonstrated in moderate and severe head injuries and may be developed by coup and countercoup mechanisms in the region of cerebral hemisphere\(^25\).

In a study by Isyaku et al on the CT pattern of head injury intracranial hemorrhage was found to be the most frequent abnormality, followed by skull fractures. Others include arteriovenous fistula and intra ocular foreign body\(^26\). A study on head injured Ghanian children conducted by M.O Obajimi et al showed that of the intracranial hemorrhage there was more extra-parenchyma hemorrhage than intra-cerebral hemorrhage\(^27\). A study in Indian showed cerebral edema to be a common intracranial finding in such patients\(^24\). Another study in Nigeria revealed that most CT findings due to head injury were cerebral
contusion, edema and subdural hematoma followed by skull fracture and extradural haematoma⁵.

Studies have revealed that majority of the epidural, subdural and intracerebral hemorrhage was found in adults more than children²⁴, ²⁸. The common site for subdural and extradural hematoma was found to be in the frontal region followed by the parietal and temporal for subdural and extradural hematoma respectively¹.

A study in Nigeria showed 87% of patients with abnormal CT findings were those with moderate to severe head injury²⁹. The incidence of CT finding was high in the patients with weakness of extremities and those that were unconscious²⁹. The occurrence of intracranial hemorrhage is very closely related to the skull fracture and the deeper the hemorrhage in the cranial cavity the greater the severity of head injury¹⁶. It was also demonstrated that as the level of severity of head injury increases, scalp laceration and skull fracture especially those of compound types and associated brain findings proportionately increase¹⁶, ³⁰. Depressed fractures are more serious due to high risk of injury to the underlying dural sinuses and brain and are commonly found in severe head injury³¹, ³². A skull fracture is considered depressed when any portion of the outer table of the fracture line lies below the normal anatomical position of the inner table.
Depressed fractures typically occur when object with a large amount of kinetic energy makes contacts with the skull over a fairly small area\textsuperscript{2}.

Yavuz et al reported in their study that linear fractures are commonly associated with epidural and subdural hemorrhage whereas with depressed fractures, laceration and brain contusion of the brain are more common\textsuperscript{25}.

Plain CT scan is the modality of choice over the conventional skull radiograph in the evaluation of skull fractures because of its higher accuracy and ability to detect fractures along with its intracranial manifestation\textsuperscript{33,12}.

Head injury is a universal problem affecting relatively young people in general and male sex in particular\textsuperscript{3, 4}. The reason for male preponderance is that males move out of their homes more frequently and are more actively working than female\textsuperscript{3}. The majority of patients with head injury are found in the third decade of life\textsuperscript{4, 6}. In a study conducted by Emejulu et al in Nnewi Nigeria the highest frequency of head trauma occurred in the 21-30 years group followed by the age groups 11-20 year and 31-40 year\textsuperscript{34}. They noted a steady decline after the age of 40 years. They were also of the opinion that patients above the age 60 years were rather less mobile and therefore unlikely to get involved in road traffic accident.

Ohaegbulum et al in a study at Enugu also revealed that majority of head injured patients are found in the second and third decade of life\textsuperscript{5}. They believed this age
group is the most active and productive group of our society and are more likely
to be exposed to both occupational and social risk.

A study in Ghana and another one in Nigeria showed road traffic accident was the
commonest cause of head injury. According to one study in Chandigarh head
injury accounted for 73% of all fatal road traffic accident cases. A work done by
Adeolu, et al on etiology of head injury in South West Nigeria showed motor
vehicular accident, for both passengers and pedestrian as a common cause of
head injury.

Data reported in literature from developed countries showed the common cause
of head injuries to be motor vehicle accident followed by vehicle pedestrian falls
and assaults. A study conducted on Indians also showed most common cause of
head injury to be motor accident followed by fall.

Nigerian and Swedish male have been reported to be more susceptible to head
injuries by motor accidents. These can be related to the more use of motor
vehicle amongst men. The etiological dominance of motor vehicle accidents is
consistent with other regional studies which shows higher incidence of head
injury in the 21-30 year groups.

Fall was the dominant etiological factor in the first decade of life, raising concern
about surveillance and supervision of the pediatric age group.
Falls routinely are the second leading cause in most incidence studies\textsuperscript{41} and tends to affect the extreme of ages\textsuperscript{6}. A study conducted in Iran also showed that the most common cause of head trauma was motor accident 72\% with fall, second at 11\%\textsuperscript{41}.

Pedal cycles account for many head injuries in childhood\textsuperscript{7}. Assault, firearms interpersonal violence, fit and recreation accident, are other important causes of head injury\textsuperscript{7}.

Most head injuries are due to blunt acceleration deceleration injuries that are the rapid deceleration, when a moving head strikes a static surface or acceleration when a static head is struck by moving objects\textsuperscript{7}. This results in local (coup) or an opposite (counter coup) injury to the brain. In contrast, penetrating injuries cause local damage especially when due to low velocity agent such as sharp object and low velocity bullets. High velocity, ballistic missiles at close range cause extensive brain damage\textsuperscript{7, 21}.

Studies have shown head injury to occur every 15 minutes and a patient dies from head injury every 12 minutes and a day does not pass that an emergency physician is not confronted with head injured patient\textsuperscript{41}. Head injury remains one of the most common reasons for seeking medical attention after injury as it is established that more than 1.5 million people are treated for head injury annually.
in the United States\textsuperscript{17}. The vast majority of head injured patients are mild but the optimal evaluation of this large group remains controversial.

It has been shown that Nigerians lack a national epidemiological data base on head injury. This indeed makes it very difficult to appreciate the scale determinants and distribution of the problem and as such make an effective intervention even more difficult\textsuperscript{33}. The lack of data also impedes the development of evidence based strategies for prevention of this injury and objective assessment of the success of any injury reduction intervention in place\textsuperscript{33}.
MATERIALS AND METHODS

Study design: This was a prospective cross sectional study in which 231 adults with head trauma referred from Trauma Center of UDUTH Sokoto to the Department of Radiology of the same institution for brain CT scan recruited consecutively.

Informed and signed consent was consequently obtained from the patients (Appendix II). The severity of head injury was assessed using Glasgow coma score taken on admission, and shortly before CT scan procedure. The severity of head injury of those patients was classified as GCS of 13-15, 8-12 and <8 for mild, moderate and severe head injury respectively. The GCS taken shortly before CT scan examination was used to correlate with the abnormal CT findings.

The data were collected using data sheets (Appendix I). The contents of the Data sheets included details of the patients’ demographic profile, cause of head injury, classification of injury severity using GCS and CT scan findings.

The materials that were used for identification of participants and measurement of the research variables include patients register, radiology request form and 4 slice GE Bright speed spiral computed tomography scanner.

Study Area: Sokoto metropolitan is the capital of Sokoto State, North-western part of Nigeria. The metropolis is made up of four local government areas viz,
Sokoto South, Sokoto North, some parts of Wamakko and Dange Shuni local
government areas. Sokoto is located between longitude 5°14” East and latitude
13°04” North. The state is bordered to the North by Niger Republic, to the East by
Zamfara State and to the South and West by Kebbi state. It has a land area of
approximately 56,000/km². The city had a population of 427,760 by the 2006
National census. Hausa and Fulani constitute the predominant ethnic groups.
They are predominantly farmers and cattle rearers.

The Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto is a tertiary
health facility which serves Sokoto, Kebbi and Zamfara state, among others as
well as part of neighboring Niger Republic. It has a bed space capacity of 850.
Inclusion criteria

All head injured patients 16 years and above admitted to Trauma Center UDUTH, Sokoto that had resuscitation and their GCS taken by a senior Neurosurgery resident or consultant and referred for CT scan of the brain in the Radiology Department, UDUTH during the study period.

Exclusion criteria

(i) Polytraumatised patients i.e. patients with injuries other than head injury.

(ii) Patients that had sedation as this will affect the GCS.

(iii) Patients with history of alcoholic intoxication.

(iv) Patients less than 16 years of age, because 16 years and above is considered as adult in UDUTH, Sokoto.
Sample size calculation

The minimum sample size was calculated from the formula below.

\[ N = \frac{Z^2 P (1 - P)}{d^2} \]

Where \( N \) = minimum sample size.

\( Z \) = Standard deviation (constant of 1.96 corresponding to 95% confidence interval).

\( P \) = Prevalence in target population estimated to have a particular characteristic.

The prevalence of head injury is 14%.\(^{37}\)

\( D \) = degree of accuracy desired (0.05)

\[ N = \frac{3.8416 \times 0.14 \times 0.86}{0.0025} = 185.01 \]

Assuming attrition rate of 20% = 100/ (100-20) = 1.25.\(^{44}\)

Optimal sample size = 185.01 x 1.25 = 231.3

A sample size of 231 patients was recruited for the study.
**Method:** All subjects were scanned from the vertex to the base of the skull in supine position using the 4 slice GE Bright speed spiral Computed Tomographic scanner manufactured 2007 fig 2. After making sure there is justification for the brain CT, the patient was made to lie in supine position on the CT table. The head is placed on the head rest and supported using head immobilization pads with straps. The straps and pads were used to maintain the correct head position. In order to prevent unnecessary irradiation of the orbit, especially the lens, the head CT is performed at an angle parallel to the infra-orbitomeatal line. The couch with the patient was introduced into the gantry where the tube rotates around the patient’s head in the gantry. The laser beam was used for indicating the starting and end point of the scan. The procedure was explained to the patient or the informant. The door of the CT room was closed and the radiographer after checking all the settings (parameters) then carried out the examination and acquired the images.

These images include the scannogram and axial slices as shown in fig 3-7. Slice thickness of 5mm and matrix size of 256 x256, field of view of 250, window width of 80 and window level of 40 were used. The bone window as well as reconstructed sagittal and coronal sections was also obtained.
Contrast medium was not administered. The images were stored in the memory of the computer. Soft copies for the patient’s images were made on LG CD recordable discs. A report was written and issued to the patient by a qualified radiologist. The expected findings are the CT features such as intracerebral hematoma (ICH), epidural hematoma (EDH), subdural hematoma (SDH), subarachnoid hemorrhage (SAH), intra-ventricular hemorrhage (IVH), cerebral edema, cerebral contusion, mid line shift, skull fracture, scalp laceration/swelling and foreign body (FB). These findings were identified using the images in the CT computer console. The widest dimension (mm) of the intracranial hemorrhage was taken. The distance between the ideal midline and the deformed midline was measured in millimeter as the degree of midline shift. The mean dimension of focal area (FA) and multifocal areas (MFA) of hemorrhage on CT were taken for correlation with head injury severity using GCS.

Data analysis

Data collection and sorting was done manually, then entered into a computer for analysis using statistical package for social science (SPSS) version 20.0. A frequency run was done for further editing and cleansing of the e-data.

Data was summarized in form of proportion and frequency tables for categorical and continuous variables using mean, media, mode and standard deviation. Chi-
square test was used to test for significance of association and spearman’s correlation was use for the correlation.

The variables are independent and dependant. The independent variables are severity of head injury (classified as mild, moderate and severe) and causes of head injury (Road traffic accident, fall from height and assault etc) while the dependent variables are the CT scan findings such as intracerebral hematoma (ICH), epidural hematoma (EDH), subdural hematoma (SDH), subarachnoid hemorrhage (SAH), intra-ventricular hemorrhage (IVH), cerebral edema, cerebral contusion, mid line shift, skull fracture, scalp laceration/swelling and foreign body (FB). All statistical analysis was set at 5% level of significance (i.e. p< 0.05).

LIMITATION

A number of the patients were in serious condition consequently information from some of the informants was therefore not precise. Patient recall for important data was difficult in few cases. Also some of the CT variables were too small for statistical computations.

ETHICAL CONSIDERATION

Ethical approval to conduct this study was obtained from the Ethical Committee of Usmanu Danfodiyo University Teaching Hospital Sokoto, and is hereby attached.
Fig 2. Bright speed (GE 4 slice) spiral computed tomographic machine.
Fig 3. Axial non contrast enhanced brain CT showing acute intracerebral hematoma in the right temporal lobe.
Fig 4. Axial non contrast enhanced brain CT showing an extensive concavo-convex hyperdensity in the right frontoparietal region with effacement of the ipsilateral lateral ventricle consistent with right acute subdural hematoma.
Fig 5. Axial non contrast enhanced brain CT showing a bilateral intra ventricular hematoma worse on the left side.
Fig 6. Axial non contrast enhanced rain CT showing a biconvex hyper-density in the right frontal lobe.
Fig 7. CT bone window of the skull showing comminuted fracture with depressed fracture segments and pneumocephalus on the right side.
RESULTS

DEMOGRAPHY

A total of 231 adult patients studied. Their ages ranged from 19 to 70 year. The most affected age group was 21-30. The overall mean age and standard deviation was 38.12 ± 13.58 years. Most of the patients 197(85.3%) were males and 34(14.7%) were females. The male to female ratio was 5.8:1. The married subjects were mostly affected 138(59.7%) and the predominantly affected populations were Muslim 217(93.9%) as shown in table 2. There was no statistical significant relationship between demographic variables and severity of head injury as shown in table 3.
Table 2: Socio-demographic distributions of study population.

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>FREQUENCY N=231</th>
<th>PERCENTAGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age group (in year)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤20</td>
<td>22</td>
<td>9.5</td>
</tr>
<tr>
<td>21-30</td>
<td>66</td>
<td>28.6</td>
</tr>
<tr>
<td>31-40</td>
<td>59</td>
<td>25.5</td>
</tr>
<tr>
<td>41-50</td>
<td>42</td>
<td>18.2</td>
</tr>
<tr>
<td>51-60</td>
<td>24</td>
<td>10.4</td>
</tr>
<tr>
<td>&gt;60</td>
<td>18</td>
<td>7.8</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>197</td>
<td>85.3</td>
</tr>
<tr>
<td>Female</td>
<td>34</td>
<td>14.7</td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>92</td>
<td>39.8</td>
</tr>
<tr>
<td>Married</td>
<td>138</td>
<td>59.8</td>
</tr>
<tr>
<td>Widow</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Religion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Islam</td>
<td>217</td>
<td>93.9</td>
</tr>
<tr>
<td>Christianity</td>
<td>14</td>
<td>6.1</td>
</tr>
</tbody>
</table>
Table 3: Cross tabulation of socio-demographic variable with severity of head injury based on GCS.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Severity based on GCS</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
</tr>
<tr>
<td>Age group (in year)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 20</td>
<td>2(5.3%)</td>
<td>12(15.1%)</td>
</tr>
<tr>
<td>21-30</td>
<td>9(23.7%)</td>
<td>21(26.6%)</td>
</tr>
<tr>
<td>31-40</td>
<td>13(34.2%)</td>
<td>18(22.8%)</td>
</tr>
<tr>
<td>41-50</td>
<td>9(23.7%)</td>
<td>12(15.2%)</td>
</tr>
<tr>
<td>51-60</td>
<td>1(2.6%)</td>
<td>12(15.2%)</td>
</tr>
<tr>
<td>&gt;60</td>
<td>4(10.5%)</td>
<td>4(5.1%)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>31(81.6%)</td>
<td>69(87.3%)</td>
</tr>
<tr>
<td>Female</td>
<td>7(18.4%)</td>
<td>10(12.7%)</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>14(36.8%)</td>
<td>30(38.0%)</td>
</tr>
<tr>
<td>Married</td>
<td>24(63.2%)</td>
<td>49(62.0%)</td>
</tr>
<tr>
<td>Widow</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Religion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Islam</td>
<td>37(97%)</td>
<td>73(92.4%)</td>
</tr>
<tr>
<td>Christianity</td>
<td>1(2.6%)</td>
<td>6(7.6%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CLINICAL SEVERITY OF HEAD INJURY BASED ON GCS

The most common type of head injury in our study was severe injury with a GCS of less than 8. Those patients that sustained severe head injuries were 114 (49.3%), moderate injuries 79 (34.2%) and mild injuries was 38 (16.5%) as shown in table 4 and fig 8.
<table>
<thead>
<tr>
<th>Severity of head injury</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild (GCS=13-15)</td>
<td>38</td>
<td>16.5</td>
</tr>
<tr>
<td>Moderate (GCS=8-12)</td>
<td>79</td>
<td>34.2</td>
</tr>
<tr>
<td>Severe (GCS &lt;8)</td>
<td>114</td>
<td>49.3</td>
</tr>
</tbody>
</table>
Fig 8. Bar chart showing the distribution of severity of head injury in our study based on GCS.
COMPUTED TOMOGRAPHIC FINDINGS

The most common CT findings among the 231 patients were intracranial hemorrhage 204(34.9%) followed by cerebral edema 168(28.6%) and midline shift 77(13.1%) as shown in table 5. Of the intracranial hemorrhage group, intracerebral hemorrhage variety was the most frequent (66.8%) as shown in table 6. Amongst patients who had fracture, 7(100%) had comminuted fracture and was found in severe head injury. Depressed fractures were seen in 3(75.0%) severe and 1(25.0%) mild head injury respectively. Non depressed fractures showed equal proportion in moderate and severe head injury 8(34.8%) as shown in table 7. There was statistically significant relationship between the type of fracture and severity of head injury, P = 0.031.

Comparison of CT findings with severity of head injury

Comparison of the different types of computed tomographic findings with severity of head injury showed CT findings of multi focal areas of intracranial hemorrhage to be 1(1.1%), 33(36.7%) and 56(62.2%) in patients that sustained mild, moderate and severe head injury respectively. Mild head injury was not associated with epidural hemorrhage, subdural hemorrhage, subarachnoid hemorrhage, intra-ventricular hemorrhage and midline shift. Epidural
hemorrhage was found in the two patients with multi focal areas (100%) that had severe injury but none of the mild or moderate head injured patients had epidural hemorrhage. Two (15.4%) of multi focal areas of subdural hemorrhage were found in moderate injury with 11(84.6%) cases in patients with severe injury. There were 6(25.0%) and 18(75.0%) of intraventricular in moderate and severe head injury respectively. Midline shift was found 16(20.8%) and 61(79.2%) patients in moderate severe head injury respectively. Among the patients studied only those with severe head injury showed CT findings of subarachnoid hemorrhage 3(100%) as shown in fig 8.
Table 5. Computed tomographic findings in the studied patients.

<table>
<thead>
<tr>
<th>CT Findings</th>
<th>Frequency</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intracranial hemorrhage</td>
<td>205</td>
<td>34.9</td>
</tr>
<tr>
<td>Mid line shift</td>
<td>77</td>
<td>13.1</td>
</tr>
<tr>
<td>Cerebral edema</td>
<td>168</td>
<td>28.6</td>
</tr>
<tr>
<td>Cerebral contusion</td>
<td>40</td>
<td>6.8</td>
</tr>
<tr>
<td>Skull fracture</td>
<td>35</td>
<td>6.0</td>
</tr>
<tr>
<td>Scalp swelling</td>
<td>62</td>
<td>10.6</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>
**Table 6. Types of intracranial hemorrhage in the patients**

<table>
<thead>
<tr>
<th>Types of intracranial hemorrhage</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intracerebral hemorrhage</td>
<td>137</td>
<td>66.8</td>
</tr>
<tr>
<td>Epidural hemorrhage</td>
<td>15</td>
<td>7.3</td>
</tr>
<tr>
<td>Subdural hemorrhage</td>
<td>26</td>
<td>12.7</td>
</tr>
<tr>
<td>Subarachnoid hemorrhage</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>Intraventricular hemorrhage</td>
<td>24</td>
<td>11.7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>205</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Table 7. Types of skull fracture with severity of head injury.

<table>
<thead>
<tr>
<th>Types of skull fracture</th>
<th>Mild (0.0%)</th>
<th>Moderate (0.0%)</th>
<th>Severe (100%)</th>
<th>Total (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comminuted fracture</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Depressed fracture</td>
<td>1 (25.0%)</td>
<td>0</td>
<td>3 (75.0%)</td>
<td>4 (100%)</td>
</tr>
<tr>
<td>Non depressed fracture</td>
<td>7 (30.4%)</td>
<td>8 (34.8%)</td>
<td>8 (34.8%)</td>
<td>23 (100%)</td>
</tr>
</tbody>
</table>

X2=10.671, p=0.031
Table 8. Distribution of CT findings with regard to severity of head injury based on GCS.

<table>
<thead>
<tr>
<th>CT findings</th>
<th>Severity based on GCS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Intracerebral hemorrhage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MFA</td>
<td>1(1.1%)</td>
<td>33(36.7%)</td>
<td>56(62.2%)</td>
</tr>
<tr>
<td>FA</td>
<td>1(2.1%)</td>
<td>17(36.2%)</td>
<td>47(61%)</td>
</tr>
<tr>
<td>Epidural hemorrhage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MFA</td>
<td>0(0.0%)</td>
<td>2(100%)</td>
<td></td>
</tr>
<tr>
<td>FA</td>
<td>2(15.4%)</td>
<td>11(84.6%)</td>
<td></td>
</tr>
<tr>
<td>Subdural hemorrhage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MFA</td>
<td>2(15.4%)</td>
<td>11(84.6%)</td>
<td></td>
</tr>
<tr>
<td>FA</td>
<td>3(23.1%)</td>
<td>10(76.9%)</td>
<td></td>
</tr>
<tr>
<td>Subarachnoid hemorrhage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intra-ventricular hemorrhage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-line shift</td>
<td>6(25%)</td>
<td>18(75%)</td>
<td></td>
</tr>
<tr>
<td>Cerebral edema</td>
<td>2(1.2%)</td>
<td>60(35.7%)</td>
<td>106(63.1%)</td>
</tr>
<tr>
<td>Cerebral contusion</td>
<td>5(12.5%)</td>
<td>15(37.5%)</td>
<td>20(50.0%)</td>
</tr>
<tr>
<td>Skull fracture</td>
<td>8(22.9%)</td>
<td>8(22.9%)</td>
<td>19(54.2%)</td>
</tr>
<tr>
<td>Scalp edema</td>
<td>9(14.5%)</td>
<td>21(33.9%)</td>
<td>32(51.6%)</td>
</tr>
</tbody>
</table>

Key: MFA - multi focal areas, FA - focal area, CT - computed tomography, GCS - Glasgow coma score.
CORRELATION OF CT FINDINGS AND SEVERITY HEAD INJURY BASED ON GCS;

INTRACEREBRAL HEMORRHAGE (ICH):

The mean dimension of intracerebral hemorrhage was found to be 35mm in severe head injury and 30mm in moderate injury as shown in table 9. These show positive correlation with severity of head injury \(r=0.231, P = 0.007\) as shown in table 10.

EPIDURAL/SUBDURAL HEMORRHAGE (SDH/EDH):

The mean dimension of epidural and subdural hemorrhage was found to be 15mm in severe head injury and 13mm in moderate injury as shown in table 9. These show positive correlation with head injury severity. EDH \(r = 0.505, P = 0.055\) and SDH \(r = 0.381, P = 0.055\) respectively as shown in table 10.

INTRAVENTRICULAR HEMORRHAGE:

The mean dimensions of the posterior horns of lateral ventricles was found to be 13mm in severe head injury while 10mm was found in moderate injury as shown in table 9 and this showed positive correlation with injury severity \(r = 0.702, P < 0.001\) as shown in table 10.
MIDLINE SHIFT (MDL)

The presence of midline shift was observed amongst patients with moderate and severe head injury, 77(13.1%) of 231 patients as shown in table 5. Midline shift less than 5mm was seen in 16(100%) patients with moderate injury and 4(6.6%) with severe injury as shown in table 11. Midline shift greater than or equal to 5mm was observed only in those with severe injury 57(93.4%). Increase in the midline shift was accompanied positive correlation with injury severity index \((r=0.690, P < 0.001)\) as shown in table 10.
Table 9. Dimensions of CT findings

<table>
<thead>
<tr>
<th>CT FINDINGS</th>
<th>fx</th>
<th>Mean dimensions in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MILD</td>
</tr>
<tr>
<td>Intracerebral hemorrhage</td>
<td>137</td>
<td>16</td>
</tr>
<tr>
<td>Epidural hemorrhage</td>
<td>15</td>
<td>_</td>
</tr>
<tr>
<td>Subdural hemorrhage</td>
<td>26</td>
<td>_</td>
</tr>
<tr>
<td>Intraventricular hemorrhage</td>
<td>24</td>
<td>_</td>
</tr>
</tbody>
</table>
TABLE 10. CORRELATION OF INTRACRANIAL HEMORRHAGE AND MIDLINE SHIFT WITH HEAD INJURY SEVERITY.

<table>
<thead>
<tr>
<th>Severity</th>
<th>Diameter ICH</th>
<th>Diameter EDH</th>
<th>Diameter SDH</th>
<th>Diameter IVH</th>
<th>Degree MLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>0.231</td>
<td>0.505</td>
<td>0.381</td>
<td>0.702</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.007</td>
<td>0.055</td>
<td>0.055</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Key: IH- Intra-cerebral hemorrhage, EH- Epidural hemorrhage, SH- Subdural hemorrhage, IVH- Intra-ventricular hemorrhage, MLS- Midline shift, CT-Computed tomography, GCS- Glasgow Coma Scale.
Table 11. Association between midline shift and severity of head injury.

<table>
<thead>
<tr>
<th>Degree of midline shift</th>
<th>Severity base on GCS</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
</tr>
<tr>
<td>Midline shift &lt; 5mm</td>
<td>-</td>
<td>16(100%)</td>
</tr>
<tr>
<td>Midline shift ≥ 5mm</td>
<td>-</td>
<td>0(0.0%)</td>
</tr>
</tbody>
</table>
PREVALENCE OF COMMON CAUSES OF HEAD INJURY

The prevalence of head injury as a result of RTA was 90% with 208 patients involved. A total of 16 patients had head injury following assault and the prevalence was 6.9%. Five patients sustained injury as a result of fall from height with a prevalence of 2.2%. Head injury due to gunshot was observed in two patients with a prevalence of 0.9% as shown in table 12.

Causes of head injury with age distribution

Road traffic accident (RTA) was the most common cause of head injury 55(26.4%), while fall from height was 3(60.0%) and assault was 7(43.8%) and they were in the age range group of 21-30 year. Those that presented with injury as a result of gunshot were found in this age group 21-30 and 51-60 years with equal proportion as in table 13. It was shown that there was no statistically significant association between age group and type of causes of head injury.
Table 12. Showing prevalence of causes of head injury

<table>
<thead>
<tr>
<th>Causes of head injury</th>
<th>Frequency</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTA</td>
<td>208</td>
<td>90.0</td>
</tr>
<tr>
<td>Fall from height</td>
<td>5</td>
<td>2.2</td>
</tr>
<tr>
<td>Assault</td>
<td>16</td>
<td>6.9</td>
</tr>
<tr>
<td>Gun short</td>
<td>2</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Key: RTA- Road traffic accident.
Table 13. Causes of head injury with age distribution

<table>
<thead>
<tr>
<th>Age (year)</th>
<th>Causes of head injury</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RTA</td>
<td>Fall from height</td>
<td>Assault</td>
<td>Gun shot</td>
<td></td>
</tr>
<tr>
<td>≤ 20</td>
<td>22(10.6%)</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td></td>
</tr>
<tr>
<td>21-30</td>
<td>55(26.4%)</td>
<td>3(60.0%)</td>
<td>7(43.8%)</td>
<td>1(50.0%)</td>
<td></td>
</tr>
<tr>
<td>31-40</td>
<td>52(25.0%)</td>
<td>1(20.0%)</td>
<td>6(37.5%)</td>
<td>0(0.0%)</td>
<td></td>
</tr>
<tr>
<td>41-50</td>
<td>39(18.8%)</td>
<td>0(0.0%)</td>
<td>3(18.8%)</td>
<td>0(0.0%)</td>
<td></td>
</tr>
<tr>
<td>51-60</td>
<td>22(10.6%)</td>
<td>1(20.0%)</td>
<td>0(0.0%)</td>
<td>1(50.0%)</td>
<td></td>
</tr>
<tr>
<td>&gt;60</td>
<td>18(8.7%)</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td>0(0.0%)</td>
<td></td>
</tr>
</tbody>
</table>

X2=16.031, P=0.38
DISCUSSION

Head injury is a global health problem and a significant cause of morbidity and mortality in Nigeria\textsuperscript{34}. Clinical assessment appears to be a better guide and this in turn guides the need for computed tomography (CT)\textsuperscript{45}. Cranial CT has been established as an accurate non invasive diagnostic modality in neuroradiology\textsuperscript{26}.

In our study the highest frequency of head injury was found in the age group 21-30 years. This agrees with many studies in Nigeria that found age group to be in the second, third and fourth decades\textsuperscript{5, 28, 45, 46}. In this study most of the patients were male 85.3%. It is universally noted that cranio-cerebral trauma is more frequent in the male\textsuperscript{47}. The male to female ratio was 5.8:1 which is similar to that found in studies in Nigeria\textsuperscript{5, 45, 46} and the western world\textsuperscript{4, 9, 17, 33} that ranges from 4.3:1 to 6.2:1. Most of the subjects in the study populations were Muslim 93.9%. This is because the study area is predominantly inhabited by Muslim.

The predominant type of head injury in our study was severe head injury 49.2% with GCS < 8, this is similar to the finding in the study conducted by Ehimwenma O\textsuperscript{46} that also showed greater percentage in severe head injury when compared to mild and moderate injuries. However, this is at variance with other studies in Nigeria\textsuperscript{5, 34} and the western world\textsuperscript{17, 33} that reported mild head injury to be the commonest type. The predominance of severe head injury over moderate and
mild injuries in our study may be partly due to the fact that more severe cases are likely to be referred to our hospital because it is a tertiary institution with a dedicated regional neurosurgery unit and among those presented with mild injury some may not be willing to do CT scan due to the cost.

Intracranial hemorrhage was the most frequent CT finding in our study (34.9%). The intracranial bleeds were mostly intracerebral hemorrhage (23.3%). The second most common CT finding was cerebral edema seen in 28.6% of the cases. These findings agree with a study conducted by Isyaku and Saidu on head trauma in Sokoto. Adeyekun and Ogunseyinde also made similar findings. However, Ogunseyinde found subdural hematoma to be the most common bleed in her study.

A study in India showed cerebral edema to be the commonest intracranial finding. We also found that greater percentage of multi-focal areas of epidural hemorrhage (100%), subdural hemorrhage (84.6%) and intra-ventricular hemorrhage (79.2%) were found in severe head injury which agrees with the study by Naseri and Moppett. Subarachnoid hemorrhage was found to be only associated with severe head injury in our study which was in consonance with the study reported by Toyoma et al. The most common intra-axial finding in severe head injury in our study was cerebral edema (63.1%) which was similar to the
report of Morgado FL. The proportion of positive CT findings among patients with mild head injury in our study was fractures (22.9%), followed by scalp edema (14.5%) and cerebral contusion (12.5%). However most of the mild head injured patients in our study had normal findings. Mohanty et al also found a high proportion of their mild head injured patients of 348 showing normal CT features. Intracranial hemorrhage was in 1.1% among those with mild head injury. All these agree with the study by Morgado, Sedat and Naseri.

In the present study, 77 (13.1%) patients had CT features of midline shift. Those with midline shift greater than or equal to 5mm were found only in severe head injury (93.4%). We also found that the presence of midline shift, regardless of other lesion was seen accompanied with statistically significant decrease in GCS, P<0.001. Chiewvit also reported a significant finding of midline shift in his patients 96 of 216. The most consistent CT findings in severe head injury in our study was midline shift of greater than or equal to 5mm which showed statistical significant relationship as the level of severity of head injury increases. In our study we found that as the severity of head injury increases associated CT findings increased as shown in table 7. This is similar to findings of Morgado, Saurabah and Abhishele.
Computed tomography findings correlated well with the GCS in our study as shown in table 8. This is in conformity with the study by Akanji et al\textsuperscript{45}, Morgado\textsuperscript{9} and Naseri\textsuperscript{22}. A study by Adeyekun\textsuperscript{48} also showed a statistically significant relationship between abnormal CT findings and low GCS, $P = 0.018$.

The most prevalent cause of head injury in this study was road traffic accident, which accounted for 90%. This value is higher than in other studies in Nigeria\textsuperscript{45,48}. However a study by Asaleye et al\textsuperscript{29} in Ile-Ife recorded same prevalence. Asaleye in her study attributed the high prevalence to the recent influx of motor vehicle and motorbike in to our country coupled with poor road and car maintenance. Assault was found to be the second common causes of head injury and this agrees with study by Chalya\textsuperscript{6} in Tanzania. However in the US fall happen to be the leading causes of head injury\textsuperscript{4,33}. Other causes of head injury in this study are fall from height (2.2%) and gunshot (0.9%). Patients were more likely to have positive CT findings if injury was sustained from road traffic accident than other causes of head injury as shown in table 13. This findings were in consonance with the study by Obajimi M O\textsuperscript{26} et all of CT features of head injury in children. These findings are also in agreement with the study by Akanjiet al\textsuperscript{45}. However, there was no statistically significant relationship in our study.
CONCLUSION

Road traffic accident was the most common cause of head injury in our study. The lower the GCS the more were the positive CT findings. The most consistent CT finding in severe head injury was midline shift of greater than or equal to 5mm which shows positive correlation with severity of head injury.

RECOMMENDATION

It is good for clinicians to use GCS along with the CT findings in order to achieve early and proper diagnosis of cases of head injury.

There is need to educate the public on the high prevalence of RTA as a common cause of head injury in our society in order to adopt a preventive measures.

Further research on this topic is required to correlate other CT findings with head injury severity index.
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APPENDIX I

DATA SHEET ON THE CORRELATION OF CT FINDINGS AND SEVERITY OF HEAD INJURY USING GCS AMONG ADULT PATIENTS IN UDUTH SOKOTO

SECTION A: BIODATA

1) Age at last birthday: (in years) _______
2) Sex: (a) male ☐ (b) female: ☐
3) Marital Status: (a) single ☐ (b) married ☐ (c) separated ☐ (d) divorced ☐
   (e) Widowed ☐
4) Religion: (a) Islam ☐ (b) Christianity ☐ (c) Others __________________

SECTION B: HEAD INJURY

5) Cause of injury: (a) RTA ☐ (b) Fall from height ☐ (c) Assault ☐ (d) Others ______
6) Duration of injury: (a) Minutes_____ (b) Hour(s)_____ (c) Day(s)_______
7) Severity of head injury

<table>
<thead>
<tr>
<th></th>
<th>MILD(GCS13-15)</th>
<th>MODERATE(8-12)</th>
<th>SEVERE(GCS&lt;8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS ON ADMISSION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCS BEFORE CT SCAN</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SECTION C: CT SCAN FINDINGS

8) INTRACEREBRAL HAEMATOMA: (a) Multifocal area ☐ (b) A focal area
9) Widest diameter of largest focus: (in mm) _______
10) EPIDURAL HAEMATOMA: (a) Multifocal area ☐ (b) A focal area ☐ (c) Associated skull Fracture ☐
11) Widest diameter of largest focus: (in mm) _______
12) SUBDURAL HAEMATOMA: (a) Multifocal area ☐ (b) A focal area ☐ (c) Associated skull Fracture ☐
13) Widest diameter of largest focus: (in mm) _______
14) SUBARACHNOID HAEMORRHAGE: (a) Yes ☐ (No) ☐
15) Thickness of the widest cistern or fissure: (in mm) _______
16) INTRAVENTRICULAR HAEMATOMA: (a) Yes □ (b) No □

17) Thickness of the widest diameter: (in mm) __________

18) MIDLINE SHIFT: (a) Yes □ (b) No □

19) Degree of shift: (in mm) __________

20) CEREBRAL OEDEMA: (a) Yes □(b) No □

21) CEREBRAL CONTUSION: (a) Yes □(b) No □

22) SKULL FRACTURES: (a) Yes □ (b) No □

23) Types of fractures: (a) comminuted □ (b) displaced □ (c) non displaced □

(d) oblique □

24) Degree of displacement: (in mm) __________

25) PRESENCE OF SCALP LACERATION/ SWELLING: (a) Yes □ (b) No □
APPENDIX II

INFORMED CONSENT TO PARTICIPATE IN RESEARCH STUDY

I am Dr. Abubakar Musa a resident Doctor with the radiology Department of UsmanuDanfodiyo University Teaching Hospital (UDUTH) Sokoto.

I am carrying out a study Titled:

Correlation of computed tomography imaging findings with Glasgow coma scale score among adult patients with head injury in Sokoto North western Nigeria.

The aim of this study is to determine the relationship between computed tomography imaging findings and clinical severity of head injury using Glasgow coma scale, to determine the frequency and common findings in the clinical severity of head injury using Glasgow coma score and to determine the most prevalence cause of head injury in the study area.

The study will help provide baseline data in the study area and will make Glasgow coma scale more useful in the management and selection of patient who will undergo brain CT scan that is not readily available and expensive.

Your participation is voluntary with no cost implication to be borne by you and you are allowed to withdraw at any stage of the study.

No financial benefit compensation to you or your ward and confidentiality of the information gathered will be ensured.
CONSENT FORM

1. I ...................................................................................................................... do here by authorized Dr. Abubakar Musa to include me in the study and use the data for the purposes of research only.

2. The nature and extend of the study have been fully explained to me and it is on this basis that I agree to allow my ward to be included in the study.

3. That the data so derived and conclusion drawn will be to my ward benefit in particular (in short run) and humanity at large (in the long run).

4. That there is no risk whatever to my wards person either directly or indirectly as a result of his participation in this study.

5. That no inducement of any form was provided by the candidate before participation in the study.

6. That I can decide on my wards behalf to stop his participation in the study at any point in time without any form of punishment being out to me either directly or indirectly.

............................................................................................................................

Signature of the subject/Date ..............................................................................

Witness/ Date
APPENDIX III

APPLICATION SUPPORTED BY:

Head of department:

Name: ..............................................................................................................................

Year of fellowship: ........................................................................................................

Signature and date...........................................................................................................

Supervisors:

1. Name: ...........................................................................................................................

Year of fellowship: ........................................................................................................

Signature and Date: ........................................................................................................
2. Name: ............................................................................................................................
   Year of fellowship: ...........................................................................................................
   Signature and Date: ...........................................................................................................
   Candidate signature and Date: .......................................................................................
APPENDIX IV

FOR OFFICIAL USE ONLY

1. Date of Receipt of Dissertation: ..............................................................

2. Date Returned to Reviewer: .................................................................

3. Date Returned by Reviewer: .................................................................

4. Date Recommended by final Reviewer: ..............................................

5. Date of Final Approval by Committee: ..............................................